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The status of medicinal and aromatic plant cultivation in Iran

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ABSTRACT

The importance of indigenous species with medicinal properties in promoting the biodiversity of traditional agricultural systems is widely recognized. Species composition and richness in cultivated medicinal and aromatic plants were studied in different areas of Iran. Results of present study showed that 54 species of medicinal and aromatic plants with a Shannon index of 0.64 were cultivated in Iran. *Lamiaceae* with 8 species and *Asteraceae* with 7 species were amongst the highest ranking plant families. The ratio of cultivated medicinal and aromatic species to the total area of cultivated lands was 0.87, of which Khorasan province showed the highest ratio and diversity amongst the all provinces studied.

Key words: Agroecosystem, cultivation, diversity, medicinal plants, species richness

INTRODUCTION

Agroecosystems are living communities of soil, plants, and animals that constitute our farms, croplands, pastures and rangelands [1]. Since most of the crops and livestock we consume are produced by agroecosystems, we can say that our lives depend on agroecosystems. Long term productivity and sustainability of food production in agroecosystems is strongly associated with the functional and structural biodiversity at all levels of genetic, species and ecosystem biodiversity [17, 18, 20]. However, in modern agriculture, high input, uniform genetic structure and hence monoculture have endangered the long term productivity and sustainability of the systems [4, 6, 15].

Most efforts made for conserving the biodiversity are towards protection of natural ecosystems. This is despite the fact that protected areas are only five percent of terrestrial ecosystems of the world and in contrast, approximately 50% of land is currently under agricultural production and 20% is in commercial forestry [22]. Biodiversity in Agricultural lands will be much more important due to the global agricultural expansion in the next 50 years. Predictions of an increase in human global population to around 9 billions [21], could result in a further one billion hectares of natural habitat, primarily in the developing countries, being converted to agricultural production, together with a doubling or trebling of nitrogen and phosphorus inputs, a twofold increase in the demand for water and a threefold increase in pesticide usage [10], which all directly or indirectly have significant effect on biodiversity.

In recent years, the question for longevity and an improved quality of life has ventured into the realm of natural therapeutics, resulting in a wider acceptance of plant-based medicines especially in the Western world. This increasing interest in natural remedies has also brought about the great challenge of maintaining a balance between the demands of expanding markets for plant-based medicines and the need to protect medicinal biodiversity [16]. It is undeniable that agricultural practices impact wildlife and biodiversity in several ways [1]. However, agroecosystems have the potential to be very productive wildlife habitats through the modification of some agricultural practices. Native and semi domesticated species with medicinal or aromatic properties can play an important role in increasing agrobiodiversity and enhancing the stability of agroecosystems. Increasing the diversity available to farmers and enhancing farmers' capacity to manage this diversity dynamically will ensure greater on-farm conservation and more useful application of genetic resources [23]. Medicinal and aromatic plants, which recently considered as new crops [9], are grown widely in natural ecosystems and contributed significantly to the socio-economic of local population for centuries. However, due to over utilization of these species in the world, widespread cultivation is being practiced in recent years.

Indeed, there is a fundamental lack of knowledge about many threatened species and habitats, particularly in developing nations [8]. No agreed set of scientific principles do exist for on-farm conservation of genetic resources [23]. Lack of such basic research in medicinal and aromatic plants

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can have implications on how we perceive particular threats or how we make decisions for conservation of agrobiodiversity. The purpose of this study was to evaluate the biodiversity level and cultivation area of medicinal and aromatic plant species in agricultural ecosystems of Iran.

MATERIALS AND METHODS

A database was built based on the information gathered from 183 counties in 24 provinces of Iran for the year 2002 by distribution of questionnaires, direct contact and reference to the statistical database of the Agricultural Ministry of Iran [12]. To calculate the proportion of land occupied by medicinal and aromatic plants in different provinces, total acreages for each plant was adjusted in relation to the total acreages in the province and then weighted means were calculated. Species Shannon diversity index [2] was calculated according to the following equation:

$$H=-\sum(n_i/N.\ln(n_i/N)) \quad (1)$$

Where H is Shannon index (H>0), n_i, cultivated land area of i^{th} species and N, total cultivated land area of all existing species in the area. Since medicinal and aromatic plants are groups of diverse plants with different life forms, total cultivated lands for all agricultural plants including field crops, orchard plants and vegetables were used for calculation of N. Also another index (H′), for biodiversity of these plants was calculated by using the same equation, but n_i/N, was calculated based on the ratio of cultivated lands for a medicinal species to the total cultivated land area of all medicinal species.

RESULTS AND DISCUSSIONS

Results showed that, Khorasan province has the highest cultivated lands and diversity of medicinal and aromatic plants, with 7 percent of the total area of cultivated medicinal species in the country and 38 percent of total area of this province under these species. Total number of species cultivated in Khorasan was 24 with a biodiversity index (H′) of 0.52 (Table 1). This seems to be associated with the diversity of climatic conditions in this province [13]. Stocking [19] stated that climatic variability is an important criterion in biodiversity of agroecosystems. Koocheki [11] also found an association between climate and species diversity for cereals in Fars, Isfahan and Khorasan provinces. However, it should be noted that large cultivated area for medicinal and aromatic plants in

Table 1. Agrobiodiversity of medicinal and aromatic species in provinces of Iran

Province	Acreage (ha)	A*	B*	Species richness	Shonnon index (H)*	Shannon index (H′)*
Bushehr	93	0.05	0.12	1	low	0
East Azerbaijan	3304	1.98	0.42	15	low	0.49
Fars	18515.7	11.1	1.95	11	low	0.48
Ghazvin	5617.5	3.37	1.89	4	0.02	0.22
Gilan	861.5	0.5	0.38	9	low	0.42
Golestan	21863	13.1	3.93	5	0.04	0.05
Hamedan	90	0.05	0.01	3	low	0.25
Hormozgan	2010	1.2	1.42	1	0.02	0
Ilam	701	0.4	0.28	1	low	0
Isfahan	1956.5	1.17	0.66	9	0.02	0.51
Kerman	8580	5.1	6.2	3	0.07	0.27
Kermanshah	5988.95	3.5	0.93	16	0.017	0.25
Khorasan	63184	37.9	6.8	24	0.097	0.52
Khuzistan	2251.84	1.35	0.33	1	low	0
Kohgeluie & Buyer Ahmad	60	0.03	low	1	low	0
Lorestan	2300	1.38	0.23	2	low	0.25
Markazi	515	0.3	0.08	11	low	0.66
Mazandaran	4033.52	2.42	0.36	9	0.02	0.42

Semnan	6093.5	3.65	4.75	4	0.06	0.17
Systan & Baluchestan	11137	6.68	5.08	6	0.06	0.18
Tehran	61	0.03	low	14	low	0.27
West Azerbaijan	211	0.1	0.01	9	low	0.35
Zanjan	7442	4.64	1.49	4	low	0.1
Yazd	657.1	0.39	0.6	4	0.013	0.4

*A: ratio of cultivated area of medicinal species to the total cultivated area in each province (%)
*B: ratio of cultivated lands for medicinal species of each province to the total cultivated lands of medicinal species in Iran (%)
*H: Shannon biodiversity index based on the ratio of cultivated area of each medicinal species to the total cultivated area
*H′: Shannon biodiversity index based on the ratio of cultivated land area for a medicinal species to the total cultivated land area of all medicinal species

Khorasan province is due to the fact that this province is the biggest producer of two main medicinal crops of Saffron (*Corocus sativus*) and Cumin (*Cuminum cyminum*). Total acreage for medicinal and aromatic crops in Iran was 166527.6 hectares which was less than one percent (0.87%) of the total cultivated land in the country (Table 2). However, 44.6 percent of this acreage is under Saffron and Cumin and a good proportion of that (43.5%) are under medicinal plants, which are cultivated for other main utilization purposes, such as fruit, oil and vegetable consumption. Therefore, only less than 12 percent of the acreage of medicinal and aromatic plants in the country was for the sole purpose of medicinal production (Table 3). Total number of medicinal and aromatic species cultivated in the country including the multipurpose species was 54 belonging to 28 plant families (Table 2 & 3). *Lamiaceae* with 8 species and *Asteraceae* with 7 species were amongst the highest ranking plant families (Table 3). Shannon index based on the total cultivated lands of the country (H) was 0.019, while this index based on the total area under the medicinal and aromatic plants (H′) was 0.064 (Table 2). Low H′ indicates a low biodiversity of medicinal and aromatic species in agroecosystems, and also to the land area distribution which is limited to a few species mainly Saffron and Cumin. Total number of medicinal and aromatic species used in traditional medicine of Iran has been reported to be up to 1100 species [3]. Since only 54 species were cultivated in the country; it appears that more than 95% of plants used in Iran are from the wild. This is similar to the situation in some other countries. For example, of about 1000 to 1500 species used in China, only 100-250 species are cultivated [24], and in Hungary with a long history in cultivation of these plants only 40 species are cultivated [5]. It has been estimated that over 70% of medicinal and aromatic plants in the world are harvested from natural ecosystems [7]. The results of this study constitute the basis for further inventorying and subsequent decision-making regarding conservation plans for the medicinal and aromatic plants of Iran. Some of the findings have important implications when planning conservation strategies, including the obvious large variation in species richness between communities/locations, the fact that most recorded species were found dominant in only one of the 24 provinces, and that communities within close proximity of each other were not consistently similar in terms of floristic composition (Table 3). In the other hand, the development of effective cultivation technologies that define plant yield in terms of both biomass and medicinally active phytochemicals is extremely important for long-term conservation of medicinal plants and their sustainable use [16]. Design and implement suitable program that accommodates the needs of the rural people in conserving medicinal and aromatic plants in the country. Ecological systems of agriculture and especially organic agriculture should always be committed to the conservation of biodiversity, both from a philosophical perspective and from the practical viewpoint of maintaining productivity, as organic farming has the potential to help in achieving the balanced biodiversity [10, 14]. Finally, while more conservation action is required, there is still a need for research that helps us understand how to conserve biota, particularly in developing countries that harbor much of the world's biodiversity.

Table 2. Agrobiodiversity and status of medicinal and aromatic plants production in Iran

Acreage of cultivated MAP (ha)	166527.16
MAP species richness	54
A*	0.87
B*	0.07
C*	5.27
Number of MAP plant families	28
Shannon biodiversity index (H)	0.019
Shannon biodiversity index (H′)	0.64

*A: ratio of cultivated area of medicinal species to the total cultivated area (%)
*B: ratio of cultivated area of alien medicinal species to the total cultivated land area of all medicinal species (%)
*C: ratio of cultivated medicinal species to medicinal species harvested from the wild (%)

Table 3. Cultivated medicinal and aromatic species of Iran

Plant species	Plant family	Acreage (ha)	A*	B*	Main production province
Achillea millefolium	Asteraceae	15.95	low	low	Khorasan,Isfahan,Tehran
Allium sativum	Alliaceae	4534	2.7	0.02	scattered
Aloe vera	Liliaceae	1	low	low	Mazandaran
Anethum graveolens	Apiaceae	158	0.9	low	scattered
Berberis vulgaris	Berberidaceae	5915	3.55	0.03	Khorasan
Bunium persicum	Apiaceae	-	-	-	Khorasan
Calendula officinalis	Asteraceae	2	low	low	Tehran,Kermanshah
Cannabis sativa	Cannabinaceae	816	0.49	low	Markazi,Isfahan
Capsicum annum	Solanaceae	53	0.03	low	scattered
Carthamus tinctorius	Asteraceae	1127	0.6	low	scattered
Chichorium intybus	Asteraceae	-	-	-	Tehran
Chrysanthemum cinerariifolium	Asteraceae	-	-	-	Tehran
Coriandrum sativum	Apiaceae	1932	1.16	0.01	scattered
Cornus mas	Cornaceae	978	0.58	low	Gilan,Ghazvin,East Azerbaijan
Crataegus oxyacantha	Rosaceae	58	0.03	low	Gilan, Ghazvin
Crocus sativus	Iridaceae	31446.75	18.8	0.16	Khorasan
Cucurbita pepo	Cucurbitaceae	16.5	low	low	Khorasan,Tehran
Cuminum cyminum	Apiaceae	42841.5	25.7	0.22	Khorasan, East Azerbaijan
Descurainia sophia	Fumariaceae	577	0.34	low	Khorasan,Isfahan
Echium amoenum	Boraginaceae	633.2	0.38	low	Gilan,Mazandaran
Elaegnus angustifolia	Elaegnaceae	5945.1	3.57	0.03	Hamedan,Yazd,Zanjan, Semnan
Fumaria parviflora	Fumariaceae	5	low	low	Khorasan
Glycyrrhiza glabra	Fabaceae	-	-	-	Fars
Hyssopus officinalis	Lamiaceae	4	low	low	Tehran
Isatis tinctoria	Fumariaceae	330	0.19	low	Kerman
Lallemanthia sp	Lamiaceae	-	-	-	Khorasan
Lepidium sativum	Brassicaceae	3	low	low	scattered
Linum usitatssimum	Linaceae	96	0.05	low	Zanjan
Lowsonia inermis	Lythraceae	3650	2.19	0.01	Kerman
Mentha sp	Lamiaceae	92.5	0.05	low	scattered
Matricaria recutita	Asteraceae	22.5	0.01	low	Khorasan,Tehran
Melissa officinalis	Lamiaceae	33	0.01	low	Tehran,West Azerbaijan
Mentha piperita	Lamiaceae	47.5	0.02	low	Khorasan,Tehran
Mentha pulegium	Lamiaceae	8.5	low	low	scattered
Mespilus germanica	Rosaceae	3209	1.92	0.01	Gilan
Nigella sativa	Ranunculaceae	9	low	low	Isfahan
Olea europaea	Oleaceae	22996.3	13.8	0.12	Gilan
Pimpinella anisum	Apiaceae	12	low	low	Isfahan
Plantago lanceolata	Plantaginaceae	-	-	-	Tehran

Plantago ovata	Plantaginaceae	-	-	-	Tehran,Isfahan
Rheum palmatum	Polygonaceae	230	0.1	low	Khorasan
Rhus coriaria	Anacardiaceae	730	0.43	low	Khorasan
Rosa damascena	Rosaceae	3381	2.03	0.01	Fars,Isfahan
Rubia tinctoria	Rubiaceae	-	-	-	Yazd
Salix aegytiaca	Salicaceae	-	-	-	scattered
Salvia officinalis	Lamiaceae	-	-	-	Tehran,Mazandaran
Satureja hortensis	Lamiaceae	50	0.03	low	Khorasan
Seasamum indicum	Pedaliaceae	31454	18.8	0.16	Kerman,Hormozagan , Systan & Baluchestan
Sinapis oleracea	Brassicaceae	546	0.32	low	Khorasan
Tanacetum balsamita	Asteraceae	19.5	0.01	low	East Azerbaijan
Tanacetum vulgare	Asteraceae	-	-	-	Tehran
Thymus vulgaris	Lamiaceae	0.7	low	low	Tehran
Valeriana officinalis	Valerianaceae	1.45	low	low	Tehran,Kermanshah
Ziziphus jujuba	Rhamnaceae	2297	1.37	0.01	Khorasan

*A: as a percentage of the total cultivated land area of medicinal species in the country
*B: as a percentage of the total cultivated land area in the country

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